Statement of

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Mr. Chairman, Ranking Minority Member, and members of the committee: thank you for inviting me to testify. My name is Joseph Taylor and I am the James S. McDonnell Distinguished University Professor of Physics and former Dean of the Faculty at Princeton University. I served in 1998–2000 as co-chair of the National Academies Astronomy and Astrophysics Survey Committee, but my comments today represent my own opinions, informed by discussions with many colleagues in the U.S. astronomy community.

As you know, the astronomy community has a long history of creating, through the National Research Council (NRC), broad surveys of the field at ten-year intervals. These surveys lay out the community's research goals for the next decade; they identify key scientific questions that are ripe for answering, and they propose new initiatives that will make those goals achievable. The most recent decadal survey, entitled *Astronomy and Astrophysics in the New Millennium*, was released in the year 2000.[1] I have been asked to answer the following questions from my perspective as the co-chair of the committee that produced that report:

1. What do you see as the most serious impacts on your field of the proposed slowed growth in the Science Mission Directorate? Clearly, it would be better to conduct more science than less, but what is the real harm in delaying specific missions? At what point do delays or cutbacks become severe enough to make it difficult to retain or attract scientists or engineers to your field?

2. Do you believe the decisions NASA has made concerning which missions to defer or cancel are consistent with the most recent National Academies Decadal Survey that you released? Have there been any developments since the Decadal Survey that need to be taken into account, and has NASA considered those? Given the FY 07 budget request, do you see any need to update the most recent survey or to change the process for the next Decadal Survey?

3. How should NASA balance priorities among the various disciplines supported by its Science Mission Directorate? Do you believe the proposed FY 07 budget, given the overall level of spending allotted to science, does a good job of setting priorities across fields?

In the balance of my testimony I shall address all three questions.

In previous decades the NRC decadal survey was an activity unique to the astrophysical sciences. The most recent survey involved the direct participation of 124 astronomers as committee and panel members; moreover, these people received input from many hundreds more of their colleagues. Altogether, a substantial fraction of the nation's astronomers were in some way involved in the creation of the report. By gathering such broad community input, the survey process creates a document that reflects the consensus opinion of the active researchers in the field. The value of this advice to NASA and the National Science Foundation has been demonstrated in many ways. It clearly helped to

[1] *Astronomy and Astrophysics in the New Millennium*, NRC, 2001.

motivate NASA's requests for the NRC to conduct similar surveys for planetary science,[2] solar and space physics,[3] and earth science.[4]

The feature of a decadal survey that distinguishes it from summaries of other fields of science is the prioritized list of recommended initiatives. This list is a valuable tool for strategic planning, and it receives considerable attention. As with the use of any tool, some judgment is required in its application. Science priorities drive the assigned priorities of the projects. The science priorities are based on the output of the research community throughout the country, including its probable extrapolation into the future. The most serious impact of the President's FY2007 budget proposal is that it threatens to significantly decrease this output by cutting the research and analysis grants lines by 15%. At a time when the administration has proposed an American Competitiveness Initiative and many members of Congress have expressed strong support for increasing research in the physical sciences, this reduction seems counter-productive at best. For the past decade NASA has provided a majority of the nation's research support in astronomy and astrophysics. The proposed reductions are therefore of considerable concern to the astronomy community.

The damage caused by these budget cuts is compounded by the fact that their impact will be disproportionately felt by the younger members of the community — the assistant professors, post-doctoral trainees, and graduate students. Without research support to pay for their time, this group will be forced to turn to other fields. Many will leave the sciences altogether, and other bright young people will decide not to enter. In a similar vein, severe reductions in the flight rate of NASA's Explorer line of smaller, lower cost missions will be damaging to the field and particularly its ability to attract and retain younger talent. The Explorer satellites have been extremely cost effective and have often been an entry point for younger researchers into mission development and project management. The scientists and engineers who will build and use tomorrow's Great Observatories are building today's Explorers. It would be a tragedy to drive these people away from space science.

It is easy to identify specific impacts of these cuts and others in the budget proposal, but I wish to call attention to a broader impact that addresses your question about the field's ability to retain scientists and engineers. The administration is proposing to reduce near term opportunities in order to fully fund large, long-term missions. At the same time it is terminating a long-planned, nearly completed facility called SOFIA and indefinitely deferring an entire program called "Beyond Einstein." I believe that the field of astronomy can sustain itself through lean budgetary times if there is opportunity on the horizon, but this budget proposal sends the message that even nearly completed missions may never be flown. It does not provide the positive view of the future that will keep members of the community engaged and attract bright young people to the field.

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[2] *New Frontiers in the Solar System*, NRC, 2003.
[3] *The Sun to the Earth – and Beyond*, NRC, 2003.
[4] Study underway - http://qp.nas.edu/decadalsurvey

The primary goal of the year 2000 Decadal Survey was to provide a vision for a sustainable national effort in astronomy and astrophysics — one that would build on the enviable position of leadership in astronomy that America has developed over the past half century and more. I do not believe that the FY2007 budget submission is consistent with this vision. I believe that NASA is trying to follow the survey recommendations, and I appreciate that it has protected the highest priority mission, the James Webb Space Telescope, and the crown jewel of the space astronomy missions, the Hubble Space Telescope, in the face of significant cost increases. However, as I mentioned when I appeared before you last year to discuss the Hubble Space Telescope, I do not believe that the highest priority missions should be implemented without regard to cost or impact on the overall program. The Decadal Survey recommended that NASA have a mission portfolio with a mix of large, moderate, and small missions. The FY2007 budget proposal is weighted to an unhealthy extent towards the large missions. The Decadal Survey recommended that NASA maintain adequate funding in research and analysis grants to "ensure the future vitality of the field." I believe that the proposed reduction in the grants line is not consistent with this recommendation.

One very significant scientific development has taken place since the Decadal Survey was released. Confirmation of the universe's accelerating rate of expansion and the existence of some form of "dark energy" have stimulated new research efforts across astronomy, astrophysics, and fundamental particle physics. The NRC's 2003 report *Connecting Quarks with the Cosmos* puts these discoveries into the broader context of understanding the universe and the physical laws that govern it. NASA worked with the community to develop its Beyond Einstein plan, synthesizing the recommendations of the Decadal Survey and the 2003 report into a widely praised strategy for investment in high energy astrophysics. NASA also participated in an interagency process headed by the Office of Science and Technology Policy which produced a detailed plan for NASA, the NSF, and the Department of Energy to move forward in this area. The NSF and DOE are implementing many of these recommendations by increasing research support and planning investments in new instruments and missions, but NASA continues to push the Beyond Einstein program into the indefinite future.

National priorities outlined in the FY2007 budget submission present NASA and the astronomy and astrophysics community with significant challenges. I do not believe, however, that a new decadal survey is needed immediately. The study we completed a little over five years ago produced a positive and forward looking document that tried to capture the scientific opportunities ahead of us. Of course science has progressed in the intervening five years, but the priorities we set still look about right. Conducting a new survey at this time would set an unfortunate precedent and encourage undesirable second-guessing at any time in the future. With these things said, it is also clear that some sort of advice from the community is needed now. In the 2005 NASA Authorization Act, Congress requested that the NRC provide NASA with a mid-decade performance assessment for each of its scientific programs. The NRC and NASA have agreed to begin this process with the astronomy and astrophysics program, and the NRC is working now to assemble a review panel. One of the goals of this study will be to provide a feasible implementation plan for the rest of this decade. Such a plan should form a solid

foundation on which to conduct the next decadal survey at its normal time, near the end of this decade.

One of the keys to crafting a feasible program is to acquire accurate information on the resources necessary to complete each mission. We attempted to gather such information in carrying out the 2000 Decadal Survey, but in retrospect it is clear that our efforts were inadequate. I believe that the correct procedure is for NASA to set up a task force to work with centers and contractors to improve the reliability of the cost, schedule and technology risk estimates, including proper contingencies, for each of the selected missions. Serious departures from these projections in the future should be grounds for consideration of mission cancellation, even for large missions of high priority.

In addition to these specific proposals, I believe it is essential that NASA work harder to communicate with its scientific community — the community that has contributed so much to the agency's successes over the years. Part of the difficulty in this particular budget cycle is that NASA's advisory bodies have been in disarray, leading to a perceived lack of community input into the agency's decision-making process. I do not believe there is a foolproof formula for setting priorities across different scientific disciplines, but it is clear that each of NASA's science disciplines must remain independently healthy. Rapid budgetary fluctuations can threaten that condition. I am confident that if the priority-setting process is done well it must include dialogue and consultation with representatives of the appropriate scientific communities. Without such discussion, budget proposals such as this one run the risk of touching off efforts outside the normal, proven planning channels to save troubled programs. This situation would eliminate one of the primary strengths of the decadal survey process: priorities based on the informed consensus of a highly competitive but ultimately cooperative scientific community.

To summarize, I believe that the FY2007 NASA budget proposal does not present a program that can provide the nation with a healthy and productive astronomy and astrophysics program. The budget proposal reduces astronomy and astrophysics at NASA by 20% over the five-year runout, before inflation is taken into consideration. The proposal damages programs that are necessary for the sustainability of a healthy research community, and it is skewed too heavily towards large missions. It may be that in the current budget climate, NASA is unable to provide the necessary resources to keep the program healthy. If so, NASA must do a better job of working with the community in order to find the best solutions to the challenges that lie ahead.

Thank you for your attention, and I will be pleased to answer questions.